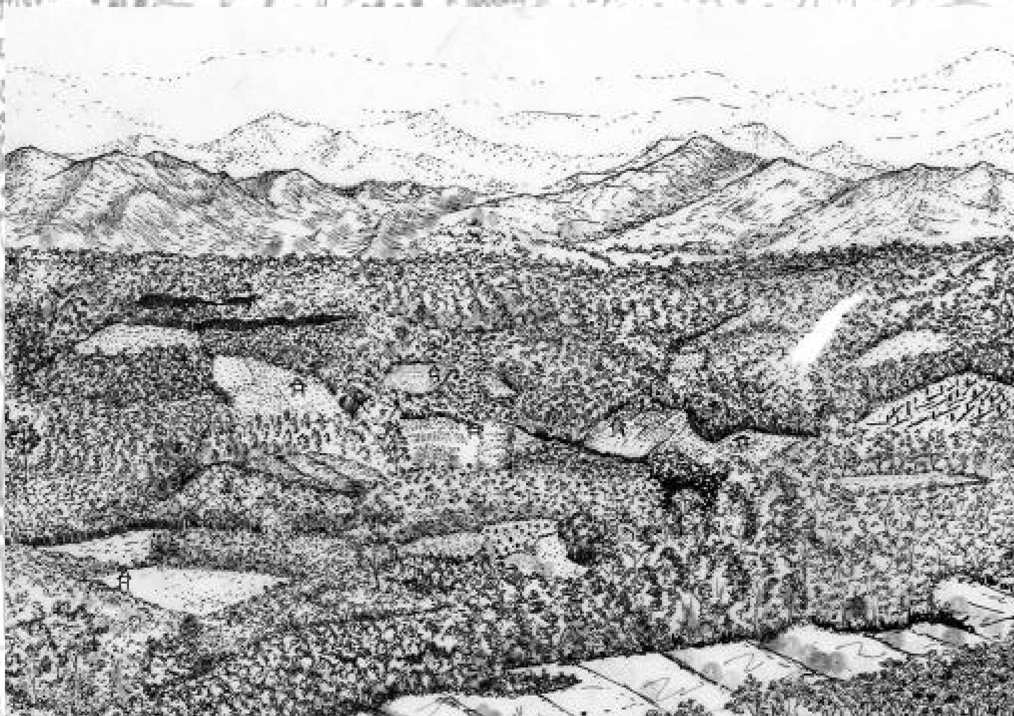
Lecture Note 4

Indigenous Fallow Management

Paul Burgers, Kurniatun Hairiah and Malcolm Cairns



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Lecture note 4

INDIGENOUS FALLOW MANAGEMENT (IFM)

By Paul Burgers, Kurniatun Hairiah and Malcolm Cairns

I. Objectives

- To provide an understanding of the various types and the evolution of Indigenous Fallow Management systems in Southeast –Asia
- Challenge the concept of a fallow as being unused land
- To provide an understanding of the importance of indigenous strategies
- To discuss the benefits and bottlenecks of various types of fallow systems

II. Lecture

1. Different concepts of the word "fallow"

In this lecture note, we will look at the fallow concept from the perspective of the primary user of the fallow, the farmer. As such, we will challenge the concept of a fallow as being temporarily unused land, a common thought of many policymakers and scientists. Case studies from farming communities throughout Southeast Asia will show that fallows are in fact carefully managed by farmers. This is done in order to achieve direct economic benefits through producing economic valuable products and/or biological (indirect economic) benefits through restoring soil fertility for food cropping.

Perception of fallow by scientists

The use of a fallow is mainly understood in the context of "resting the land". The conventional thought on what constitutes a fallow is, that

"during a fallow period after a cropping season, land is abandoned (land is just covered by planted or regrowth vegetation) in order to rejuvenate the soil fertility and/or disrupt pests and diseases" (after Ruthenberg, 1976).

In dry temperate zones, especially the USA, fallows refer to bare land, kept without vegetation to increase soil water storage. The conventional scientific view was that when land becomes scarce, with a growing population that needs to make a living on this land, fallow practice is seen as expensive, inefficient and uncertain. In the past, most research on improving shifting cultivation methods has therefore been concentrated on the cropping period and on a reduction of the fallow period, since fallow was regarded as unused land. Where the fallow functions of soil fertility restoration and pest reduction were recognised, it was thought that intensification of foodcropping could be achieved by applying inorganic fertiliser and pesticides. Since then with a growing concern for the natural environment, more low-input, sustainable options for agriculture were sought. A growing number of social and bio-physical scientists these days judge that fallow in the farming system is a rational and crucial component of many agricultural systems, both for productive and protective reasons.

Perception of fallow by the policy makers

The conventional thought (and its scientific arguments) of what fallow is, was largely adopted by policy makers. Combined with their concern for food security for the population, and an increasing land pressure, this has led to a stimulation of the conversion of fallow systems into what is said to be more permanent, more productive and more profitable land uses. In many cases, government programmes have been and still are directed at the conversion of fallow practices towards permanent forms of agriculture, e.g. on the incorporation of cash crops on “unused” fallowed land, and applying fertilisers and pesticides on remaining agricultural land (see box 1).

The fact that a fallow can sometimes be very productive was generally overlooked, as conventional science did not have a complete understanding of what constitutes a fallow.

Box 1: Misconception of what a fallow is, may result in livelihood degradation: examples from Laos and Sarawak.

The government of Laos set a target to end shifting cultivation practices by the year 2002. For this reason, most current fallow-land will be redistributed among the rural communities. The fallow period should not exceed four years (where it is still above 8 years). This is very disadvantageous for shifting cultivation communities in Laos, who enriched their fallows with for instance teak trees, paper mulberry trees and trees that produce benzoin. In particular teak and benzoin need at least 8 years before they can be harvested. The investment in these tree-crops will be lost, since part of the land will be given to other families, while trees on the remaining land will not reach maturity in four years time.

In Sarawak, East-Malaysia, policy makers view shifting cultivation as an old, inefficient and unproductive form of agriculture with the current size of the population. Shifting cultivators in Sarawak are stimulated to enter the “cash-economy” by planting perennial cash crops like cocoa and pepper. For this purpose, part of the fallow vegetation is converted into cash crop gardens. As this leads to a decrease in the fallow length as well, decline in food self sufficiency is the result, as the time for the fallow vegetation to restore soil fertility becomes too short. Secondly, the fallow is enriched with rattan and fruittrees like durian. Building on these practices becomes more difficult, as these products also need a minimum amount of years to mature.

Although well intended, these government programmes would have been more successful if they had understood the important roles that fallow management strategies fulfil to sustain livelihoods.

Perception of the fallow by the primary users, the farmers

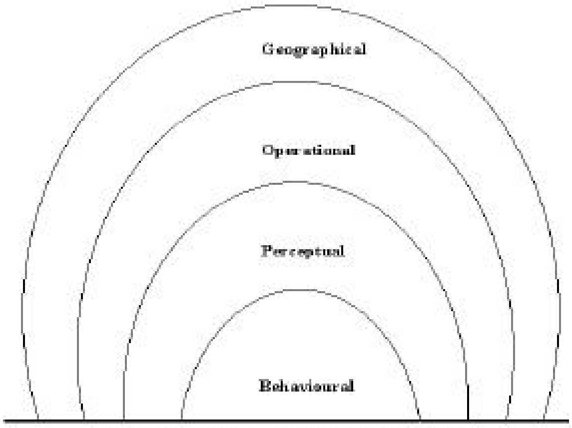
It is striking to note that in this debate the concept of a fallow from the point of view of the primary user, the farmer, is given only little attention. A fallow is part of an integrated farming system, in which multiple objectives for the livelihoods of the farmers have to be met. Fallows exist for a number of biological and socio-economic reasons. Examples are: the restoration of soil fertility after cropping, the decrease of erosion and the opportunity to gather a number of products from the fallow vegetation for sustaining the livelihoods of the household. Examples of these products are edible ferns and fungi, bamboo and timber as construction material for houses or fences and tree-fodder for livestock. These products sustain livelihoods through the provision of food, fodder, firewood, and cash through the sale of products.

2. The rationale of a fallow for the farmer

Farmers are the primary users of the fallow, and the primary decision makers with respect to the utilisation of the land.

Box 2: The context in which a farmer operates is crucial for understanding fallow functions

Sonnenfeld (1972) has developed a “behavioural” classification of environment. This may serve to explain how complex the relations are between "contextual triggers", like bio-physical circumstances, policies, social structures and the ultimate choice of a certain type of land use system by a farming household. Opportunities and constraints farmers have within such a given context condition the decision to manage natural resources in a certain way (here a fallow).



The human environment

In short, the **geographical environment** is the “universe” external to the farmer. This is the same for every farmer. It is often referred to as the physical environment, and is said to be a given context (climate, soil structure, relief, and so on). The formal political environment is often incorporated as well (in many cases the lack of participation in the formal political process makes the political system external to most farming communities). It impinges on him directly or indirectly, or not at all.The **operational environment** is more or less literally the environment (natural and social) in which a farmer operates. It is the part of the natural environment that the farmer is able to “manipulate” or change, and in return influences the behaviour of the farmer. It is the direct environment of the farmer, which includes the natural characteristics of his farming area, as well as the social/political environment on a “local” level. For instance he may be operating under an informal political system, like Adat in many parts of Indonesia, or has to survive on degraded lands or cope with erosion or prevent erosion by protecting vital forest areas. The operational environment differs from farmer to farmer, community to community and country to country, as it consists of a value system, cultural factors, economic systems, environmental factors, and so on. The **perceptual environment** is that part of the operational environment of which the farmer is aware through learning and experience. A farmer therefore has a certain perception of how he could e.g. manipulate the fallow vegetation, based on his experience with farming in that locality. The **behavioural environment** is not a simple and straightforward reaction to the objective a farmer has for his farming system. It is the environment in which human behaviour begins and decisions are taken. It is the interpretation of reality, resulting from distortions in the environments as described above. This gives farmers opportunities or constraints to follow a certain path of natural resource management (or fallow management) and intensification.

Therefore, real life decisions on land uses are never optimal in the sense that profits are maximised or costs minimised.

The farmer must keep a balance in distributing his available local resources (like land, labour, capital, time) among all activities on- farm as well as off-farm (if available): foodcropping and managing the fallowed lands, householding and other jobs to obtain a cash income (seasonal or year-round employment). The farmer's values and preferences towards farming, management of the fallow vegetation and division of "resources" are a consequence or a reflection of his perception of the environment. This perception is embedded and deducted from a process of learning and experience (see box 2) of farming in that locality. We must understand that the farming system that has evolved is a result of the opportunities and constraints a farmer has from the resources he can apply, the opportunities the natural environment offers them, and the "freedom" a farmer gets within the social structures they are part of. For instance, many shifting cultivation communities believe that ancestors continue to live in the ricefield, and therefore must plant rice every year. On the other hand a farmer is pushed into new directions from a wider socio-economic and political context in which he operates, so they can "survive".

Swidden cultivators themselves have been remarkably innovative in devising their own ways to manage fallow lands. These management systems have developed from internal initiatives and are known under the term indigenous fallow management systems.

In the absence of more profitable options to earn a cash income, farmers throughout Southeast Asia have developed their own management strategies to the fallow vegetation in order to sustain/improve their livelihoods. These dynamic strategies respond and adapt to changes in the social, economic, political and environmental context (or in other words, responses to changes in) the geographical and operational environment).

Indigenous management strategies are directed at the integration of the fallow and its functions to sustain/improve the livelihoods. These strategies are often perceived as "traditional". However, these systems have been developed and tested by farmers, and have been flexible and able to respond and adapt to changing needs and aspirations of the households over time, without involvement of formal research and extension services.

As stated before, general understanding exists on the restoration of soil fertility in its physical, chemical and biological aspects. The concept of providing vital productive functions has in most cases not been well understood by scientists and policy makers, dealing with improving the productivity of these systems, although in managing the fallow vegetation supports the livelihood needs with additional food, fuel, and a necessary cash income.

Which type of fallow might suit the livelihood needs of the farmer?

3. Evolution of intensifying fallow systems

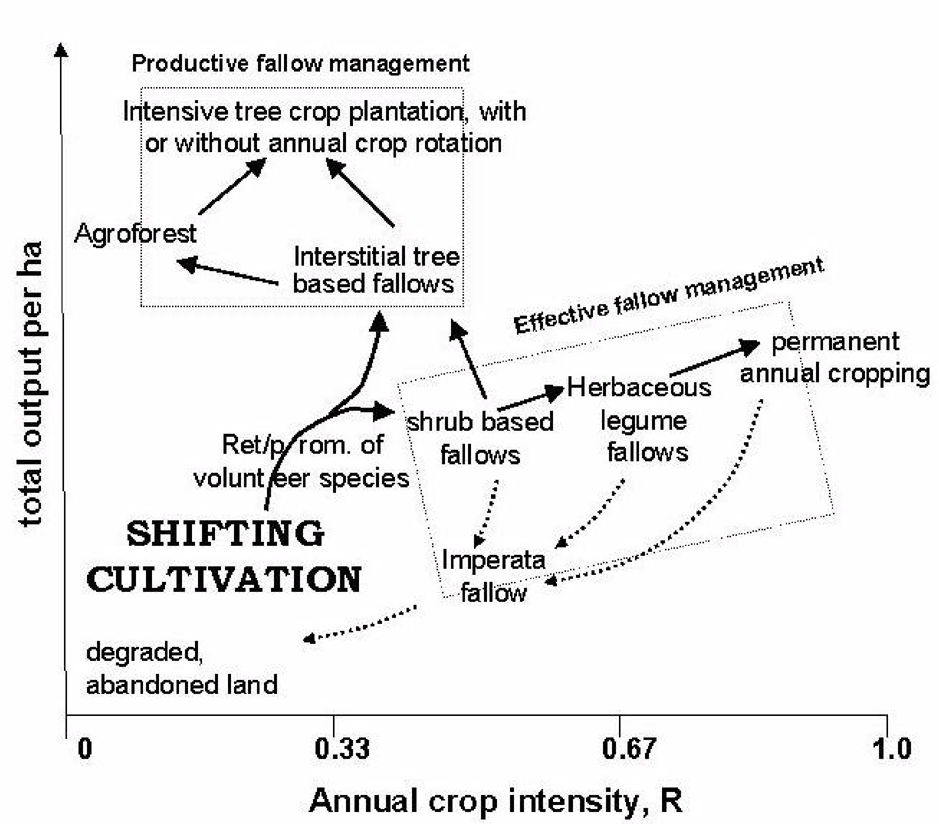


Figure 1. Evolution of intensifying swidden systems as function of total output in physical yield per ha.

In figure one, the process of how intensification of fallow systems can evolve is summarised. Where land is abundant compared to the size of the population, shifting cultivation is usually based on short cropping periods combined with long forest-fallow periods, during which a secondary forest vegetation establishes. On the X-axis in fig. 1, annual cropping intensity is defined as the fraction of time (or land) used for annual food crops as part of the total cropping cycle (area). This is known as the R-value. Using this R-value as an indication for understanding the development of shifting cultivation, it means that the land is cropped for less than one-third of the time. The remaining land is left fallow. In other words, the cropping intensity of the land is less than one third ($R < 0.33$). If the R-value is higher than 0.67, the system enters the phase of continuous cropping, and fallow management has seized to exist. As illustrated in Fig. 1, those systems partly out of the boxes are at the edge of what is considered fallow management. Continuous cropping systems may consist of annual or perennial crops (e.g. rubber agroforests). Between these two options, the fallow systems are most dynamic according to their biological and socio-economic functions (the R-value roughly varies between 0.33 and 0.67). This dynamic phase is caused by changing circumstances or a changing operational and geographical environment (social, political, economic and environmental change), like population growth, land pressure and the fact that many communities in Southeast Asia have developed strong links with urban areas and the monetary economy. These changes in the geographical environment made most farming communities to redirect the fallow more towards the economic/productive functions. From examples later on in this lecture note, it can be seen that many communities have gradually decreased the area for subsistence foodcropping, and converted the fallow vegetation towards more permanent, more economic attractive tree crop based agroforestry type of systems (with or without commercial foodcropping, like vegetable growing).

4. Indigenous strategies to manage fallows

Depending on the "contextual triggers" from a wider economy, the decisions made by households to manage the agricultural system, indigenous fallow management strategies are said to be variations between two options:

Effective fallows

If subsistence farming (food cropping) remains crucial or the only option for the farmer in the context of increasing land use pressure, intensification of land use requires that the soil restoring functions of a fallow have to be obtained in less time. The fallow vegetation has to be managed in such a way, that the fallow vegetation comprises of those species that can speed up the soil restoration. The knowledge of the local environment enables a farmer to select those species that may be "more effective" for a rapid restoration of soil fertility, and to propagate them in the fallow. This direction of intensification would be most appropriate for communities where households are constrained in developing alternative livelihood strategies besides food cropping. A higher output per ha must be obtained by increasing the cropping intensity. In this way, more people can grow food crops on a smaller area of land. It allows a higher human 'carrying capacity' (in short, more people can make a living on the same amount of land). At one point in time however, the land will be cropped more than two-thirds of the time ($R > 0.67$) and becomes 'continuous cropping' (see figure one).

Productive fallows

When the geographical and hence the operational environment increases accessibility to intensify links with urban areas and the monetary economy, a farmer has more options to diversify the agricultural production, and does not need to solely focus on food security. If the farmer's perception is favourable, he may decide to slowly reorganise his available resources, and increase the (economic) productivity of his fallow. In the beginning, the main objective of the total farming system is still food cropping, but he starts to manipulate the fallow vegetation to favour "desirable economic" species. Access to large enough and diversified markets and access to other on- and off-farm income opportunities allows the farmer to take this risk to gradually move away from food cropping. Food could be bought with the money earned from either off-farm employment or harvest from tree products. In fact, access to off-farm employment is often viewed crucial to make the shift away from food cropping, as this income can bridge the gap between the planting and maturation of these trees. If the geographical and operational environment allows, the food-cropping phase may eventually disappear and permanent perennial gardens develop, referred to as agroforests. This marks the end of fallow management, turning into (semi-) permanent perennial (cash crop) gardens.

Indigenous Fallow Management systems (or Fallow rotation systems) are therefore all systems between on one hand shifting cultivation and on the other hand agroforests, tree-crop plantations or continuous cropping.

Box 3: Distance is a relative concept

Distances are conventionally shown true to their length on an absolute scale of kilometres or miles, but it may be more appropriate to measure them in relative terms, when distance is viewed primarily as a barrier to "spatial interaction (Dictionary of human geography, 1989).
For instance in Laos, spatial interaction with markets does not take place over distances larger than 20-50 kilometres, whereas in Sumatra a distance of over 150 kilometres still enables farmers to have intensive links and a market oriented agriculture. As such, distance is related to time and space. How fast should specific farm products like e.g. perishable fruits reach a market? At what distance from the market can farm products still be produced in a profitable way, considering all costs for producing, processing and transport?

Indigenous fallow management practices in Southeast Asia cover a broad spectrum, from systems focussing mainly on annual food crops (effective fallows) to systems where the woody vegetation dominates (productive fallows). An organisational framework for analysis of indigenous fallow management practices and systems in Southeast Asia is presented in figure 2. As explained above, within this "framework" households either manage the fallow in order to increase the soil fertility properties of the fallow (to the right), or concentrate more and more on increasing the direct economic advantages of the fallow (products itself), with or without a food cropping mode (to the left).

Productive fallow management Effective fallow management

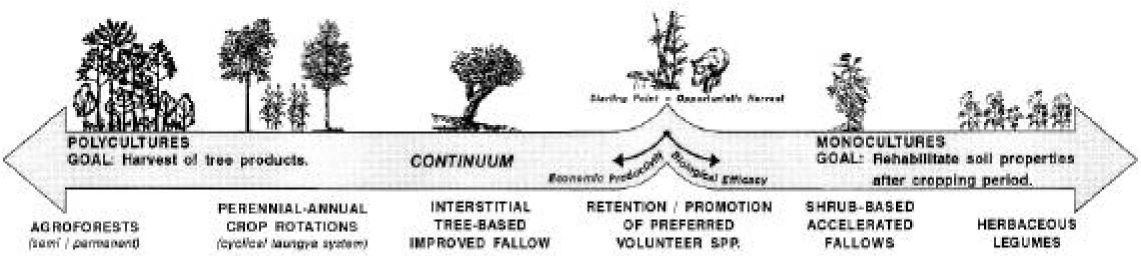


Figure 2: Possible trajectories of indigenous fallow management systems

These strategies and systems could provide an essential starting point for the so far too often disappointing results of programmes aimed at improving the livelihoods of shifting cultivation communities in upland areas. Project managers were (are?) often misled by pseudo-adoption of new techniques. Putting indigenous strategies in the front seat in programmes to intensify shifting cultivation systems, may contribute to a more appropriate "farmer-developed" intensification and diversification of the agricultural systems in the uplands of Southeast Asia, which fits the real world of the farming communities.

5. A trajectory of specific fallow management systems

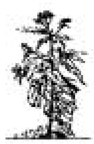
In this paragraph we explain a bit more in detail the six fallow management systems and how they can evolve into each other. As these are mostly food-crop based, in the end we will briefly discuss fallow systems with a livestock component. This often concerns an introduced, but very important component, and has therefore a specific place in fallow management (5.7).

5.1 Retention/promotion of preferred volunteer species.

The first step towards more active management to increase specific functions of the fallows is the promotion of vital species that have become scarce to the household. These often consist of products, which were originally collected from the natural forest. As the economic value increased (shortage in combination with a higher demand), these products may help to satisfy certain needs of the household (either for food or cash). Farmers started to propagate these products in their fallow vegetation. Good examples of this first phase of fallow management are the numerous rattan based fallow systems throughout Southeast Asia or increased planting of other (edible) forest products. During this phase, the main objective is still food security through on-farm growing of the staple crop rice. The original form of shifting cultivation remains intact, although initial management of the fallow has started through enrichment plantings.

In Sarawak and large parts of Kalimantan, for instance, farmers have planted ferns, rattan and fruit trees, which formerly thrived in the natural forest, in the regrowth of the secondary fallow vegetation.

After this phase, it will mainly be the effect of further change processes (from the geographical and operational environment), which will result in a certain perception of the environment of the farmer, to focus still on food cropping or to move into the direction of increasing the economic productivity of the fallow vegetation. If the farmer has no other option than to focus on increasing the biological functions of the fallow, the following systems evolve.



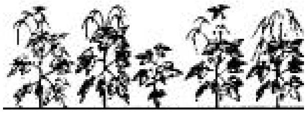
5.2 Shrub based accelerated fallows

This is often a first step in developing a more effective fallow. If the fallow is long enough, farmers use shrub based accelerated fallows to sustain food crop production. As farmers throughout Southeast Asia have learned by experimentation over the years, *Chromolaena odorata, Tithonia diversifolia, Austroeupatorium inulifolium* and other Asteraceae shrubs have beneficial agronomic properties. In Sumatra, Minangkabau farmers use *Austroeupatorium inulifolium* to improve soil fertility and to shade out Imperata grass (see box 3).

In the Philippines, *Mimosa invisa Martius ex Colia*, a weedy legume, locally known as Benit, is used to improve soil properties. Farmers have viewed this species as being able to provide compost, green manure, and mulch and it protects the soil from compaction and erosion. According to the farmer, this sustains the productivity of their corn and other crops.

In Northern Thailand, *Mimosa diplotricavar* is used by farmers to combat weed infestation in orange orchards and upland crops, with the knowledge that it is also beneficial to soil fertility.

5.3 Herbaceous legume fallows



If the length of fallow periods decreases further, farmers may begin to promote certain herbaceous legumes to improve soil fertility. In Northeast India, farmers use *Flemingia vestita* as it fixes nitrogen, while the tubers are eaten. This legume is rotated with annual crops.

Certain bean type plants provide nitrogen-fixing opportunities, while at the same time the beans can be eaten. Although quite common in South America and West Africa, it occurred only sporadically in Southeast Asia. Among others, this has to do with the attitude towards consumption of beans, as rice is the staple food in Southeast Asia. However, there are cases in Northern Vietnam, where the NoNhe bean (*Phaseolus carcatus* Roxb.) is rotated with a maize crop in an 8 months fallow. (Maize can be harvested after 4-5 months).

In China, Li and Miao indigenous tribes in the mountainous area in Hainan Island use the Yazhuo Hyacinth Bean. As a dry season fallow crop, it provides food through the beans while the stems are used as fodder for livestock.

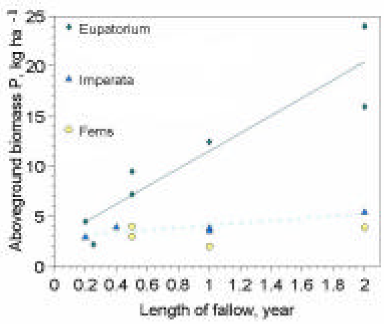
However, as fallow periods decrease, the danger of this type of fallow management is that the fallow becomes so short, that soil properties cannot be restored anymore. The biological functions of the fallow decrease, ultimately leading to "over-intensification". Symptoms are:

a increased weed pressure
b reduced soil structure
c increased pest frequency

In Southeast Asia, this “over-intensification” has led to the establishment of an aggressive weed, called *Imperata cylindrica*. Once established, the land will be hard to cultivate, and is generally not productive as *Imperata* does little to restore soil fertility (although *Imperata* fallows may prevent complete soil degradation). This may be true from a biophysical point of view, but farmers do not always view *Imperata* as a “weed”. Farmers in Bali, Indonesia, have found good use for *Imperata* fallows, and are even promoting the growth of it on their land. The grass is widely used for roof thatching. Many hotels on Bali and other parts of Indonesia are using this grass to construct roofs. The sale of this “weed” provides the farmer with a considerable income.

Box 4: Farmer’s knowledge matches scientific knowledge

Improved *Austroeupatorium* fallows for rehabilitating *Imperata* grassland in West Sumatra, Indonesia.



Austroeupatorium inulaefolium is an aggressive shrub (Fam. *Asteraceae*) native to tropical America. During the early years of the century, it was introduced to West-Sumatra, Indonesia, to combat Imperata in commercial tree plantations. It became naturalised throughout the study area and is now a major pioneer species that often dominates fallow successions. Although it is considered a weed in some parts of the world, it is highly valued by Minang farmers for its agronomic and ecological functions within bush fallows and because it provides several benefits, such as poles and firewood. It is of particular interest as a spontaneous fallow succession species at higher altitudes. Rapid regrowth and high biomass production, copious shedding of branch and leaf litter, efficient scavenging of nutrients and fast soil fertility rejuvenation have allowed farmers to shorten fallows and intensify land use without surpassing the ecological capacity of the local environment. This has significantly decreased the need to expand agricultural land and thus has reduced pressure on protected forest margins.

Scientific data confirm that the knowledge and experience gained by farmers in using this species has positive effects on crop growth (see graph above).

A low P-availability (due to a high Al/Fe - P fixation) on acid soils very often limits plant growth. Since *A. inulifolium* appeared in the study area 50 years ago, analysis of the soils and fallow vegetation on a sample of farms provided empirical evidence that the indigenous knowledge accumulated by Minang farmers is more than valid. From the graph, it can be seen, that aboveground biomass accumulated much faster in Austroeupatorium fallows than in those of alang-alang (Imperata) or ferns (*Pteridophyta*). Two-year old fallows produced 12 - 23 ton ha^{-1} of dry matter, compared with 5 - 6 ton ha^{-1} for the grass and ferns. This increased biomass contained 3-4 times more P (see graph above) and is likely to improve productivity of subsequent crops.

Source: ***ICRAF annual report 1995, page 169-170***

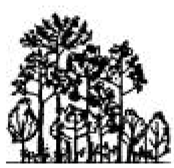
5.4 Interstitial tree based improved fallows

Alternatively, where conditions allow households to move away from food cropping, more productive fallows develop. Seeing the close links that most farming communities in Southeast Asia have with the monetary economy, this type of fallow management is quite common. Eventually the reopening of the fallow vegetation and cultivation of annuals may be abandoned, as the tree crops become the main agricultural products.

In these systems, economically valuable trees are planted on a wide scale in the fallow. In many parts of Eastern Indonesia (Sumba, South-Sulawesi, Timor) leguminous trees like *Sesbania sesban* and *Leucaena leucocephala* are valued for their soil fertility enhancing properties, at the same time providing high quality fodder for cattle. The Amarasi system of West-Timor is a good example, where *Leucaena leucocephala* fodder-fallows are rotated with maize. In Nagaland, Northeast India, *Alnus nepalensis* provides soil fertility properties as well as firewood and timber for housing. Finally, in Papua New Guinea fallow composition is manipulated by promoting certain species, like *Parasponia rigida, Schlenitzia novo-guineensis, Albizia spp* to provide the family with timber for house construction, fencing and firewood. In Laos, teak trees are intercropped in the fallow the first years after planting and will provide timber for sale and home consumption. Teak planting near roads has increased so much now that these systems move into perennial-crop rotation systems, described below.

5.5 Perennial-annual crop rotation

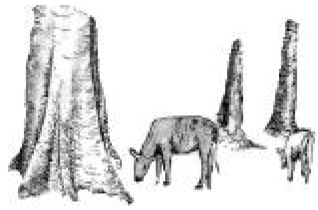
If commercialisation continues, more intensive propagation of economic valuable trees may be the result. These systems are often called commercial shifting cultivation, whereby (commercial) food crops (e.g. vegetables) are rotated with economic valuable trees. The cinnamon-coffee agroforests in Kerinci, West-Sumatra provide a good example. Together with vegetables, farmers plant coffee trees, while after two years seedlings of cinnamon trees are incorporated. In this way, farmers are secure of short term cash income from vegetables, medium term income from coffee, and long term savings come from the cinnamon trees. Many systems consist of timber trees rotated with annual crops, like the use of *Melia* spp, in farming communities of Northern Vietnam or the indigenous paper mulberry tree (*Broussonetia papyrifera*) in Northern Laos in rotation with rice. The inner bark is used to make coarse-textured parchment for handicrafts and other uses.



5.6 Agroforests: the endproduct of more productive fallow management

The examples of the rubber agroforest systems of Sumatra (Gouyon et al., 1993) have evolved from 'enriched' fallows in which several rubber trees were planted in the fallow vegetation to satisfy the cash needs of the farmers. Increasing demand for rubber, higher prices, increased marketing opportunities, and farmers needing to diversify or find alternative options for a decreasing agricultural productivity increased the propagation of rubber into what is now known as highly productive tree based systems, the rubber agroforests. Another example of permanent agroforest can be found in Southwest China where the lacquer tree *(Toxicodendrom vernicifera*) is permanently intercropped with undergrowth of tea bushes.

For further examples and more detailed description of the agroforests, see the lecture notes on “Complex groforests” (De Foresta, H., Michon, G., Kusworo, A. Complex Agroforests, 2000).



5.7. Livestock and fallow management for promoting the fodder component

A rather specific position is taken up by those systems, in which the livestock component becomes more important. With the introduction of livestock, fallow management may evolve towards increasing the fodder value of the fallow vegetation. These types of systems may develop at any time along the continuum, and from every type of fallow management system. Livestock may first of all be introduced from outside as an alternative option to degrading fallow management systems (See 5.3).

The reasons for introducing livestock to combat degradation are many. The most important reasons are:

- Where fallow periods have become too short to strengthen soil fertility, livestock provides manure to fertilise degraded soils.
- The sale of cattle provides an income for the farmers.
- When dual-purpose cattle is introduced (for milk and meat) the family is able to consume milk.
- It can also provide draught power.

The livestock versus tree-crop components are often spatially differentiated when land is abundant (for instance this can be seen in the more semi-arid areas of Eastern Indonesia, like Nusa Tenggara where pastures can be found next to fallow-crop systems). The fallow vegetation provides additional fodder, while dung is used to fertilise the fields. With a change in the geographical and operational environment, and land becomes more scarce, the livestock and food crop components are pushed towards more functional and spatial integration: A decrease in area for natural fodder supplies, like grazing areas or loss of fodder collection sites in forested areas may push a farmer to grow fodder on farm. A loss of access to arable land pushes him to intensify and integrate the two components on one piece of land. In such cases, farming households adapt and choose to manipulate the fallow vegetation and its functions to satisfy both fodder as well as soil fertility values to enable sustainable food cropping.

Many examples from Southeast Asia have shown that farmers have successfully adapted to change by improving the fodder value of the fallow vegetation.

An interesting example of introduced and adapted technology can be found in the Amarasi District, West Timor, East Indonesia. The Dutch Colonial government introduced *Leucaena leucocephala* to combat the growth of the weed *Lantana camara* and to provide farmers who possessed cattle with a high quality fodder. Farmers learned that Leucaena was not just a good fodder, but it could also improve soil fertility. In this case, fodder fallows of *Leucaena leucocephala* were rotated with maize. In Laos, farmers are incorporating *Brachiaria decumbens* species in their fallow to provide enough quantities of feed for their cattle. Cattle may either browse the fallow vegetation or get fodder in a cut and carry system as part of (semi-) zero grazing units.

These former practices may provide interesting and more sustainable alternatives to degrading fallow management systems, (from an economic or soil fertility perspective). Functional and spatial integration of cattle and foodcrops may provide the farmers with fertilisers and cash through the sale of cattle, while leguminous tree fallows with good fodder value provide cattle feed and improve soil fertility for sustainable food cropping.

BUT: We must understand under what social, political, economic and environmental conditions these systems could be viable.

6. Criteria for evaluating plant species suitable for Fallow Management

Before selecting a suitable plant for fallow management purposes, it is very important to determine what is the main objective of this fallow (improve soil fertility, increase the financial profit or both). Below, a number of criteria of plant characteristics and their potential benefits are given.

No	Criteria	Potential benefits
1	High adaptability to a wide range of climates and soil conditions	• Easy to establish under different conditions
2	Fast growing plants	• Shade out weeds, reduce labour needs for weeding • High biomass output (maintaining soil organic matter, nutrient status)
3	Deep root system	• Relatively more tolerant to drought • Acting as 'safety-net' of leached nutrients from deeper layer (in poor soil, e.g. ultisols) • Acting as 'nutrient pump' (in rich soil)
4	Symbiosis with *Rhizobium* or *mycorrhiza*	• Increased availability of N and P in soil
5	Tolerance to pruning	• Reduce labour for replanting • Increase income e.g. as fodder, fire wood, …
6	High coverage after harvesting	• Easy established • Reduce labour for replanting • Reduce seeds cost
7	Less vulnerable to pest and disease	• Less cost for insecticide
8	Flexible in management (planting, pruning, harvesting etc.)	• No time conflict with other labour demands
9	Low input/low management requirements	• Low costs for labour/capital
10	Trees as a savingsbank or to provide daily cash needs.	• Short term cash and/or long term saving through the cutting or harvesting of trees for cash

Discussion

Could you think of more criteria to evaluate the suitability of species in either effective or productive fallows?

7. Most common pathways for fallow management in Southeast Asia

In Southeast Asia, farming communities have built strong links with the monetary economy and urban centres, which enabled the commercialisation of the farming system (the operational environment has changed). Commercial types of agriculture often require more investments (seeds, inputs and so on). Exposure to "city-life" and the improved access to services (schools, hospitals, agricultural services, entertainment and so on) increase the interest and need for a cash income. This will influence the perception of the environment and finally his behaviour (his behavioural environment) and the fallow is valued more in terms of its economic productivity.

Factors that have contributed to these developments are:

- Effective fallows are not "popular". In most Southeast Asian countries, the staple crop is rice. There is no tradition in the consumption of e.g. beans in rotational leguminous fallow systems.
- Shifting cultivators have been using trees in order to satisfy multipurpose objectives for cash, food, fuel, fodder, and to claim land by planting economic valuable trees on areas with an "open access".
- Southeast Asia's long history of indigenous tree crops that produce spices for world markets may have helped further in market channel development, commercialisation and attitude towards growing trees.
- Increasing population pressure and decreasing land availability make it difficult to leave the land fallow long enough for sustainable foodcropping. A decrease in food self-sufficiency means that farmers must try something else to buy the necessary food and other items).
- Heavily subsidised consumer prices of rice (the main staple crop in Southeast Asia) in a number of countries makes it relatively easy to buy rice and to produce "more economic valuable crops" (e.g. commercial valuable tree crops) in the fallow period. As farmers often receive relatively low farm-gate prices for their rice, it is easier to buy rice from the harvest of "economic valuable fallow crops".
- A change towards productive fallow management options would not have been possible, if the farming communities were not linked to areas, where alternative employment could be found, while markets have become accessible for their farm products.

Farmer cutting Tithonia

8. Are Indigenous Fallow Systems a lasting option for sustainable agriculture?

This is a difficult question to answer, as every indigenous system develops within a specific context. However, generalisations are possible as the evolution of the systems have commonalties, which can be used to guide a sustainable intensification of fallow systems:

- Most critical is the ability to respond to rising demographic pressures by enabling *a sustainable intensification of land use*. Rising demographic pressure and land shortage will lead to further land use intensification. Land use pressure may hamper a sustainable tree cropping system.
- We stated that the development of effective fallows might lead to over-intensification, resulting in the degradation of the agricultural system. If productive fallow management evolves into agroforests, they may be (agronomically) sustainable, as they safeguard specific ecological and economic functions initially provided by the (secondary) forest.
- Planting of trees is in general a more extensive form of land use compared to annual cropping. Therefore, there is a point in time, where in the absence of other alternative employment and income generating opportunities (e.g. off-farm employment), the amount of land becomes too small for a farmer to make a living from tree crops. Adaptation to these circumstances may result in cutting down the trees, and more intensive, more profitable options are established, like the growing of vegetables. This has occurred for instance in Kerinci, West-Sumatra, where in some areas cinnamon and coffee agroforests were cut down to make way for commercial vegetable growing.
- Incentives to stimulate "tree-cropping". An example from Northern Vietnam shows that with the right "incentives" in line with their livelihood objectives, farmers are interested in planting trees. Almost bare hills with a grass-type vegetation for cattle grazing have been converted into fruit tree plantations of litchi. Some driving forces were favourable policies and market access for these fruits, profitability and problems with herding buffaloes, which was the former activity on these hills.

This shows the importance of how the "context" in its broadest sense affects the "behavioural environment" of the farmer. Farmers may therefore decide to either plant or cut down trees, after judging the opportunities they have within a certain context. Some **political and other contextual triggers** that are all interrelated and may influence management of natural resources and in particular fallows are mentioned below.

- Informal regulations: Land and tree tenure relationships

Informal regulations are those that individuals use to shape their own everyday behaviour. As such, Adat Law falls in this category, as the villagers themselves developed these regulations, including a "way of life and customs". In many cases, fallow land is part of Adat or customary law. Often this fallowed land is communal property, in which people can harvest and collect products. It will be the strength of the Adat law system to be able to change to allow more intensified plantings of useful species (often more individual ownership). As such, Adat is a local system of regulations, which are flexible and subject to change according to new aspirations and needs of the villagers.

On the other hand, land ownership does not always have to be a prerequisite for tree planting. In many areas of Indonesia and India, many sharecropping arrangements exist. As long as the person who plants the tree has the right to harvest the tree products or even to cut it down, tree planting is not always negatively affected, even on other people's land (e.g. rubber agroforests and cinnamon trees in Sumatra).

Rather than obtaining secure land rights, secure tree rights are important, as harvest security could be a main driving force for planting trees.

- Formal regulations

Formal regulations are those set out by authorities, such as laws and regulations. Policies are able to shape the conditions under which these systems may have a future. It must be the willingness of the political systems to recognise fallow management as a sustainable practice from an agronomic and socio-economic point of view, and to provide the conditions to enable a sustainable way to manage the natural resources in fallow management systems.

In the end it will be the farmers who must benefit from indigenous or external developed technologies. We must understand carefully under what conditions certain systems evolve and make sense. This will help to understand and guide wider applicability of certain systems to areas where degradation of the agricultural system has occurred.

Discussion

- Could you give a brief description of an apparent promising IFM technology in your country? Where are they currently practised? What are possible benefits to farmers? Why do you think these particular systems have developed?
- What is a potential wider domain for adoption?
- Key questions that research should usefully address?
- Can you think of more reasons why productive fallows are more popular?
- Could you think of more “contextual triggers” that may support or disable certain fallow management practices?

9. Remaining research questions

One important question is under what conditions do farmers decide to manage the fallow in a certain way? More specific questions are:

For effective fallows

a) What are **the most critical fallow functions** on each site for the crops used? Is it related to N, P, cation supply, soil-born diseases or weed control?
b) How rapid is the recovery of "soil fertility" during a fallow?
c) Is the fallow phase based on "mining" non-renewable soil resources, or is it exploiting a renewable resource?
d) How can farmers manage the recovery fallow vegetation during a cropping period? Does it become a weed?
e) How can the farmer re-establish the improved fallow after a cropping period?

For productive fallows

a) What are the most critical fallow functions? A combination of economic value and soil fertility, or economic production only?
b) What minimum land size may enable these practices?
c) Are certain productive fallow management systems location-specific? Or is there potential for extrapolation?
d) Are there more functions of the tree-component besides yielding economic products to make them attractive to farmers?

Overall question cutting across the different fallow management systems

Would the introduction of a livestock component be a viable option to provide farmers with an income and a more sustainable form of fallow management?

10. Food for thought: (socio-economic) sustainability for whom or what!

This is a fundamental question for agricultural development and in particular tree crop systems. With an increasing urbanisation and monetarisation of the economy, fallow management encounters problems with decreasing land size through population growth and land development for large-scale agriculture. Farmers may cope with these difficulties by leaving the agricultural sector or leave the land, to find employment outside agriculture. Or they may migrate to “virgin” areas, and open up forests to start a "new life". As stated before, this behaviour results from the opportunities and constraints farmers have within the “human environment” (box 2).

For instance, in highly commercialised tree crop areas in Sumatra, e.g. the rubber agroforests in Jambi Province, and cinnamon systems of Kerinci, West Sumatra, many rich people make a living outside agriculture. Earnings from these activities are re-invested in the acquisition of land, either by buying land or opening up forests. Money earned from off-farm employment is invested in tree crops, which serve as a savingsbank. They also tend to buy land from farmers, who do not get access to “new” opportunities to earn cash income. As a means of “survival” they sell the land and than have no other option than to become labourer on their former land, now owned by the rich farmers. Therefore, although these systems may be sustainable from an agronomic point of view, they may not be so sustainable from a socio-economic point of view, as they increase social and income inequity. We have to try and understand the (socio-economic) implications of certain interventions and how they affect the majority of rural people! In particular we can learn from the indigenous strategies how rural households try to adapt to change and sustain their livelihoods, and how this affects the lives of rural communities in general.

11. Some reflections for policymakers

Conventional science recognised the fallow functions of soil fertility restoration and pest reduction, but generally thought that these functions could easily be replaced by inorganic fertiliser and pesticides to make 'effective fallow systems' even more effective.

Productive fallow systems hardly got any recognition, not by scientists, nor by policymakers. Recognising those systems and recognising indigenous strategies, may contribute to a more appropriate “farmer-developed” intensification and diversification of the agricultural systems in the uplands of Southeast Asia for a number of reasons:

Built on local knowledge and local (livelihood) strategies, systems can develop within the constraints and opportunities of their context (their “human environment”).

Indigenous strategies have evolved with low cost and in most cases with little or no outside (expensive) technologies and a high amount of capital.

- The approach provides a better understanding of the accessibility of local resources to the farmer. Understanding why management flexibility of fallow and trees makes sense within the rationale of the farmer, makes it possible to develop **different types of management options**, depending on the needs and opportunities of the farmer.
- In this way, **systems are flexible** and can be gradually refined and intensified by the farmers themselves in response to changing circumstances, e.g. the systems adapt to increasing land use pressures and changing needs.

Enabling and guiding such management flexibility by the farmers themselves may then become a new challenge for the policy makers and scientists to understand how farming communities are able to cope and adapt to outside pressures in a sustainable way.

III. Reading material

Proceeding

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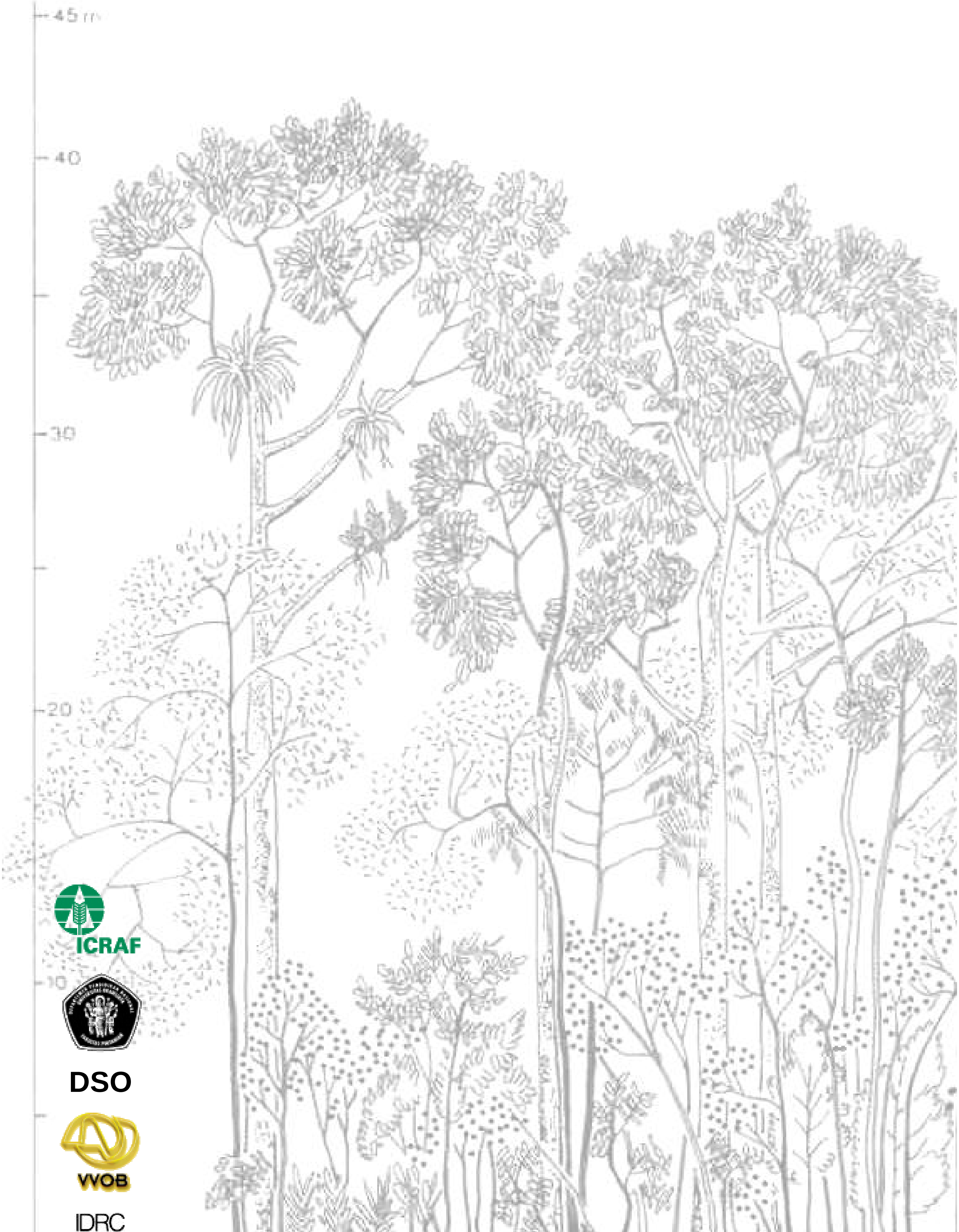

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